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REGULATED POWER SUPPLIES

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INSTRUCTION MANUAL

OVERVOLTAGE/OVERCURRENT
PROTECTOR

MODEL VIP 4

SERIAL NO. C-645 49

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SECTION I - INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This instruction manual contains information for the installation, operation and maintenance of the KEPCO VIP-4 OVER VOLTAGE/CURRENT PROTECTOR.

1-3 GENERAL DESCRIPTION

1-4 The KEPCO MODEL VIP-4 is an accessory device for connection to DC power supplies to protect external loads from DC overvoltage or overcurrents which can develop as the result of a malfunction in the power supply or in the load circuitry. When the VIP-4 is triggered by either an overvoltage or an overcurrent it instantaneously "crow-bars" the power supply and operates an internal relay, the contacts of which (normaly open and normaly closed) are available at the rear barrier strip. These contacts may be used to operate an external contactor or circuit breaker which then would remove the AC input power to the power supply. Following triggering, the internal relay remains energized until the VIP-4 is "reset". In addition to the visual indicator on the front panel (pilot light) the protector has an outlet in the rear which is energized with 115V AC in case of triggering.

1-5 The Model VIP-4 may be connected to operate with any KEPCO power supply whose DC output rating and input power are within the specifications of the VIP-4. Other DC power supplies whose output and input ratings are similary within the rating of the Model VIP-4 and which are capable of withstanding the application of a short circuit may also be used.

1-6 SPECIFICATIONS, ELECTRICAL

a) Voltage Mode

1) Sensitivity: Minimum threshold 1% of operating voltage or 0.1 volts whichever is greater.

2) Range: Adjustable in the range of 3 to 50 volts.

b) Current Mode

1) Sensitivity: 5% of operating current producing a 1 volt drop across an external sensing resistor,

2) Range: 0 to 200 amperes.

c) Response Time

1) Shunting across the output (crow-baring) occurs within 50 μ sec. after triggering.

2) Input Power Disconnect Signal (Relay) occurs approximately 50 milliseconds after triggering.

d) Maximum Input Current of Power Supply: Depending on selected external circuit breaker or contactor. The internal relay contacts actuating the external device are rated for 10 ampers (non-inductive) rms current.

e) Input Power Requirements (VIP-4 only): 105 to 125V AC or 210 to 250V AC, approximately 10 watts, 45 to 400 Hz, single phase.

1-7 SPECIFICATIONS, PHYSICAL

a) Dimensions: Height 3 1/2", Width 19", Depth 11" (over-all behind panel)

b) Finish: Light Gray per Federal Standard: 595 Color #26440, unless otherwise specified.

c) Mounting: Panel fits standard 19" rack.

SECTION II - INSTALLATION

2-1 UNPACKING AND INSPECTION

2-2 The KEPCO Model VIP-4 Overvoltage/Overcurrent Protector has been completely tested and inspected at the factory prior to packing and is ready for installation and operation. It should be unpacked with reasonable care and inspected for shipping damages. Notify the responsible carrier if any evidence of such damage exists.

2-3 TERMINALS AND CONTROLS (Refer to FIG'S 2-1 and 2-2, also TABLES 2-1 and 2-2)

a) Front Panel Controls and Terminations

1) POWER SWITCH, "ON-OFF" toggle switch, controlling the input power to the VIP-4.

2) FUSE, protects VIP-4 circuitry only. Opening of this fuse, or setting POWER SWITCH (1) to "off" position will also release the internal relay and thereby shut of the connected power supply. (As will any momentary or permanent removal of line power from the VIP-4).

3) AC PILOT LIGHT. White pilot light indicates line power turned "on".

4) OPERATE LIGHT. Amber pilot light indicates VIP-4 in OPERATING mode.

5) FAULT LIGHT. Red pilot light indicates fault condition, VIP-4 has triggered. Will remain "on" until cause for fault has been removed and unit has been reset.

6) VOLTAGE CONTROL. Continuous adjustable 10-turn control for setting the voltage within the range of the VIP-4 at which triggering will occur. Maximum voltage is at the extreme clockwise position of the control.

7) TEST/OPERATE SWITCH. Disables the internal relay and crow-bar circuit in the TEST position for set-up and readjustment purposes.

8) SENSITIVITY. A continuous control for setting the triggering threshold above the set operating voltage.

b) REAR TERMINATIONS

1) REAR BARRIER STRIP. Contains remote error sensing terminals, relay terminations and terminals for special operating procedures. (Refer to Section III of this manual)

2) OUTPUT TERMINAL (-) } To be connected to corresponding output
3) OUTPUT TERMINAL (+) } terminals on power supply.

4) ALARM RECEPTACLE. Outlet for connection of an alarm device. Output is 115V AC when unit is in FAULT condition. Current carrying ability: 0.25 A, rms non-inductive.

5) INPUT LINE CORD. Three wire safety line cord, supplying AC power to Model VIP-4.

2-4 OPERATION ON OTHER THAN STANDARD POWER LINE

2-5 The Model VIP-4 is normaly supplied for operation on a 105 to 125V AC, 45 to 400 Hz, single phase line. To operate on 210 to 250V AC, locate transformer T1 (Refer to FIG. 5-2) and remove bare wire jumpers between terminals (1)-(2) and (3)-(4) on the printed circuit board. Connect jumper between terminals (2) and (3). Do not remove any other wires. Proceed in reverse order for reconversion to 105-125V AC operation.

2-6 GROUNDING

a) AC Ground. The power supply is equipped with a 3 wire safety line cord and polarized plug. The third (green) wire in the line cord is connected to the chassis and the case of the unit. If a two terminal receptacle in combination with an adaptor is used, it is imperative that the chassis of the power supply be returned to AC ground with a separate lead.

b) DC Ground. All DC input terminals are isolated from ground.

NOTE: It is important that the ground potential between the power supply ground and the VIP-4 ground is as small as possible to prevent spurious triggering of the device due to ground pick-up. If possible, a common ground lead should be constructed, connecting both units together and then leading to a good ground.

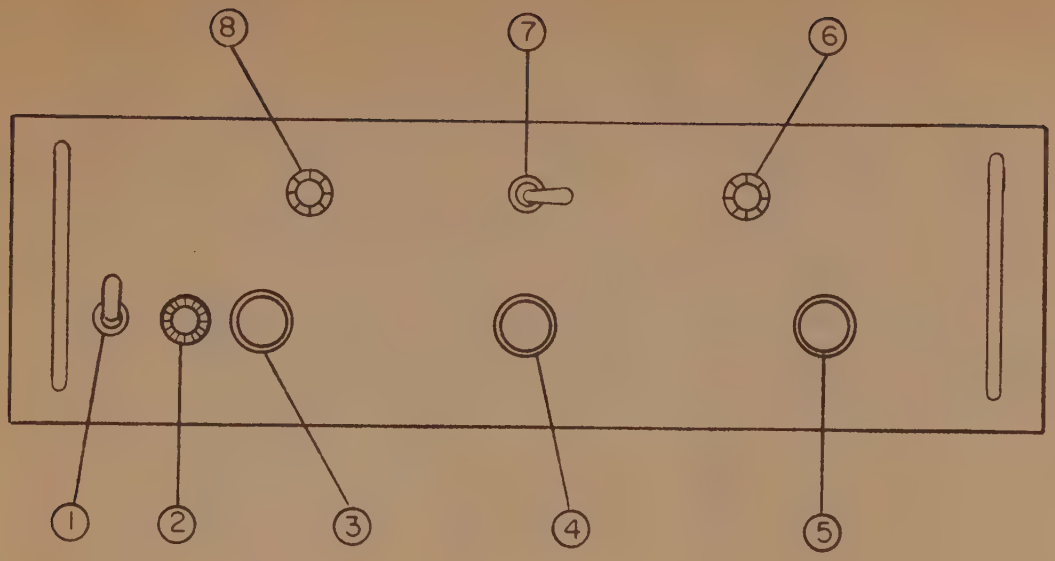


FIG. 2-1 FRONT PANEL CONTROLS AND TERMINATIONS

NO.	CONTROL OR TERMINATION	FUNCTION
1	POWER SWITCH	TURNS LINE POWER "ON-OFF".
2	FUSE	PROTECTS TRANSFORMER OF VIP-4.
3	PILOT LIGHT (WHITE)	INDICATES LINE POWER "ON" WHEN ENERGIZED.
4	PILOT LIGHT (AMBER)	INDICATES INSTRUMENT IN "OPERATING" MODE WHEN ENERGIZE
5	PILOT LIGHT (RED)	INDICATES "FAULT" CONDITION WHEN ENERGIZED
6	VOLTAGE CONTROL	SETS OPERATING LEVEL FROM ZERO TO 50 VOLTS
7	SWITCH	CONNECTS INSTRUMENT TO EITHER "TEST" OR OPERATING MOD
8	SENSITIVITY CONTROL	SETS TRIGGER LEVEL.

TABLE 2-1 FRONT PANEL CONTROLS AND TERMINATIONS

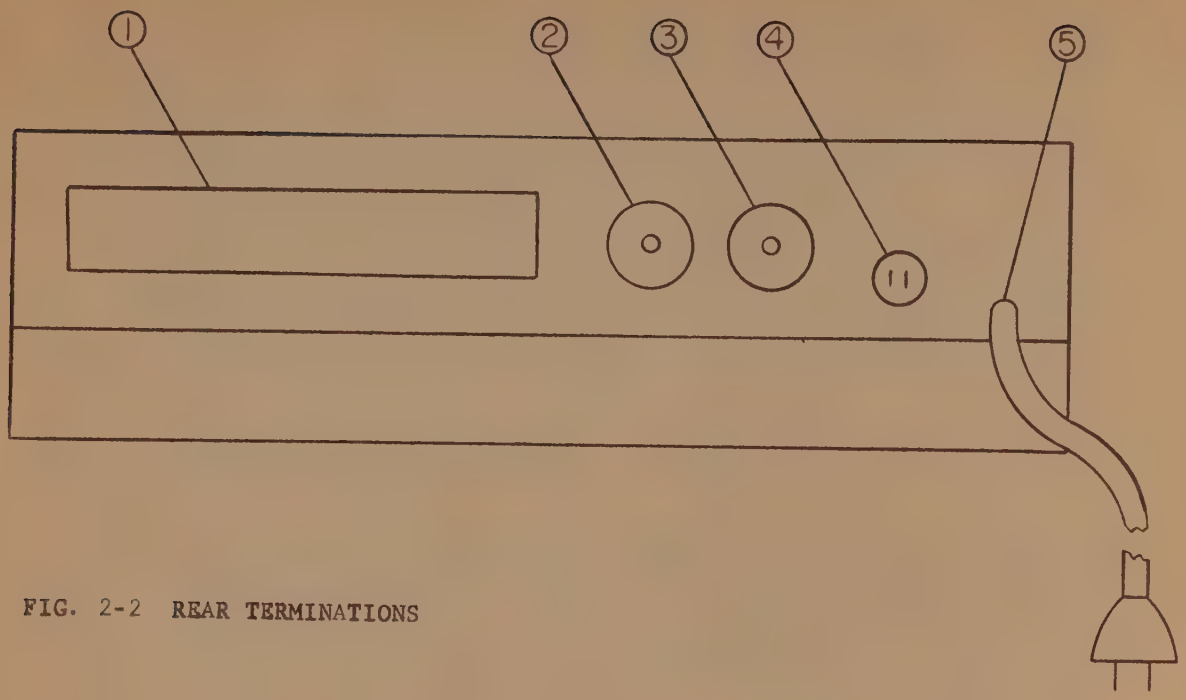


FIG. 2-2 REAR TERMINATIONS

NO.	TERMINATION	FUNCTION
1	REAR BARRIER STRIP	INPUT TERMINALS (SEE SECTION III FOR DETAILS)
2	OUTPUT TERMINAL (-)	TO BE CONNECTED TO CORRESPONDING OUTPUT TERMINALS OF POWER SUPPLY
3	OUTPUT TERMINAL (+)	
4	ALARM RECEPTACLE	ENERGIZED WITH 115V AC UNDER "FAULT" CONDITION
5	LINE CORD	CONNECTS DEVICE TO POWERLINE

TABLE 2-2 REAR TERMINATIONS.

SECTION III - OPERATING PROCEDURES

3-1 GENERAL

3-2 The KEPCO Model VIP-4 Overvoltage/Overcurrent protector is shipped with removable jumper-links between terminals (4)-(5), (7)-(8) and (9)-(10)-(11). These links must be in place and secured tightly for standard overvoltage operation of the VIP-4 and if the VIP-4 is connected across the load itself, rather than to the power supply. The method of operation is similar to that described in paragraph 3-3 below. (See also FIG. 3-1)

3-3 STANDARD OVERVOLTAGE OPERATION

3-4 Description. In this mode of operation, the model VIP-4 is set to trigger at a preselected voltage within its range, chosen to be some value above the intended operating value of the power supply. The operation in this mode is perhaps best described by means of an example. A load is connected to a power supply with an output of 24 volts. An overvoltage of 1 volt shall crow-bar the power supply.

3-5 PROCEDURE (Refer to FIG. 3-2)

a) Remove jumper links on the Model VIP-4 between terminals (4)-(5) and (7)-(8) and connect operating set-up as shown in FIG. 3-2. Attention is called to the importance of the crow-bar leads which must contain a minimum resistance of 1 milli-ohm/volt, in this case 24 milli-ohms. Set all controls on the Model VIP-4 to their maximum clockwise position. Set TEST/OPERATE switch to "TEST".

b) Turn VIP-4 "on" before power supply. Turn power supply "on". The white AC pilot light should be energized. Set power supply to its designated operating voltage. (24V) Monitor with voltmeter parallel to the output terminals.

c) Slowly adjust VIP-4 VOLTAGE CONTROL Counter Clockwise until the red FAULT light goes on. (This means the Model VIP-4 would now crow-bar exactly at 24 volts, the preadjusted output voltage on the power supply).

d) Slowly adjust the SENSITIVITY control counter clockwise to the desired upper threshold level (1 volt). One full turn of this control yields approximately 5% of the operating voltage i.e. 1.2 volts in our example. The FAULT light will now be out again and the Model VIP-4 is ready for operation as soon as the TEST/OPERATE switch is turned to the OPERATE position.

e) Before switching to OPERATE however, the set-up may be tested by disconnecting the load and advancing the power supply voltage control beyond 24 volts. The FAULT light should now go on at about 25.2 volt. If larger or smaller threshold voltage is desired it may be adjusted at this point by either counter clockwise (greater threshold voltage) or clockwise (smaller threshold voltage) rotation of the SENSITIVITY control. Test again as described above.

f) Reconnect load, set the TEST/OPERATE switch on the VIP-4 to OPERATE. The Model VIP-4 is now ready to operate.

3-6 TRACKING OPERATION

3-7 Description. In this mode of operation the Model VIP-4 is connected directly into the sensing circuit of a power supply and tracks the full output voltage of this supply. The VIP-4 will in this case respond only to an unbalance in the sensing circuit of the power supply which may be caused by shorted pass elements or other defects. This unbalance will produce an error signal in the sensing circuit which is used as the input signal for the Model VIP-4.

3-8 The tracking method of operation is specifically designed for KEPCO feedback regulated power supplies or units of similar design where the error signal at the sensing circuit terminals is virtually zero at balance, and which use the negative terminal as their common lead. (PNP pass-elements)

3-9 PROCEDURE (Refer to FIG. 3-3)

a) Remove links on the rear barrier strip of the Model VIP-4 between terminals (4)-(5) and (9)-(10)-(11). Connect operating set-up as shown in FIG. 3-3. Set SENSITIVITY control on the Model VIP-4 fully clockwise and the TEST/OPERATE switch to TEST.

b) Turn on VIP-4 (before power supply). Turn on power supply. The operating set up is now complete. Any malfunction in the power supply will trigger the Model VIP-4 and crow-bar the power supply. To test the operating set-up proceed as described in par. 3-9C.

c) Disconnect load and shut off power supply and VIP-4. Connect monitoring voltmeter and another, variable power supply (supply #2) across the output of the original supply (supply #1) in the operating set-up. Turn on VIP-4 and power supplies. Increase voltage setting on power supply #2 beyond that of supply #1 and note triggering point of the VIP-4. This point may now be varied from the maximum sensitivity previously adjusted to the threshold level desired. Test again as described above.

d) Reconnect load. Remove power supply #2 and set the TEST/OPERATE switch on the VIP-4 to OPERATE. The Model VIP-4 is now ready to operate.

3-10 OVERCURRENT OPERATION

3-11 Description. In this operating mode the Model VIP-4 senses a small voltage drop across a resistance placed in series with the DC load current which the power supply delivers to the load. The voltage across this "sensing resistor" is proportional to the load current and is used as an error signal to trigger the VIP-4 in the event of an overcurrent. The sensing resistor should be of such a value as to drop approximately 0.5 volt at the desired operating current. It should preferably be built as a four terminal network and must have sufficient power rating to exclude thermal drift.

3-12 PROCEDURE (Refer to FIG. 3-4)

a) Remove links on the rear barrier strip of the model VIP-4 between terminals (4)-(5) and (9)-(10)-(11). Connect operating set-up as shown in FIG. 3-4. Set SENSITIVITY control to its max. clockwise position. Set TEST/OPERATE switch to TEST.

b) Turn on VIP-4 before power supply. Turn on power supply. Rotate SENSITIVITY control until the red FAULT light goes on. Back off on the SENSITIVITY control until the FAULT light is just estinguished. The VIP-4 is now set up for operation as soon as the TEST/OPERATE switch is thrown to OPERATE. If the operating set-up is to be tested, proceed as directed in paragraph 3-12C.

c) Connect substitute load and adjust to actual operating current. Connect ampere meter in series with load. Turn on both VIP-4 and power supply (in that order), set VIP-4 TEST/OPERATE switch to TEST and advance power supply current control to draw a load current beyond the actual operating current. Observe actual triggering point simultaneously on the ammeter and by the energizing of the FAULT light. The SENSITIVITY control may now be varied to the desired cut-out point and re-checked by the procedure just described.

d) Re-connect actual operating load, set TEST/OPERATING switch to OPERATE. The Model VIP-4 is now ready for operation.

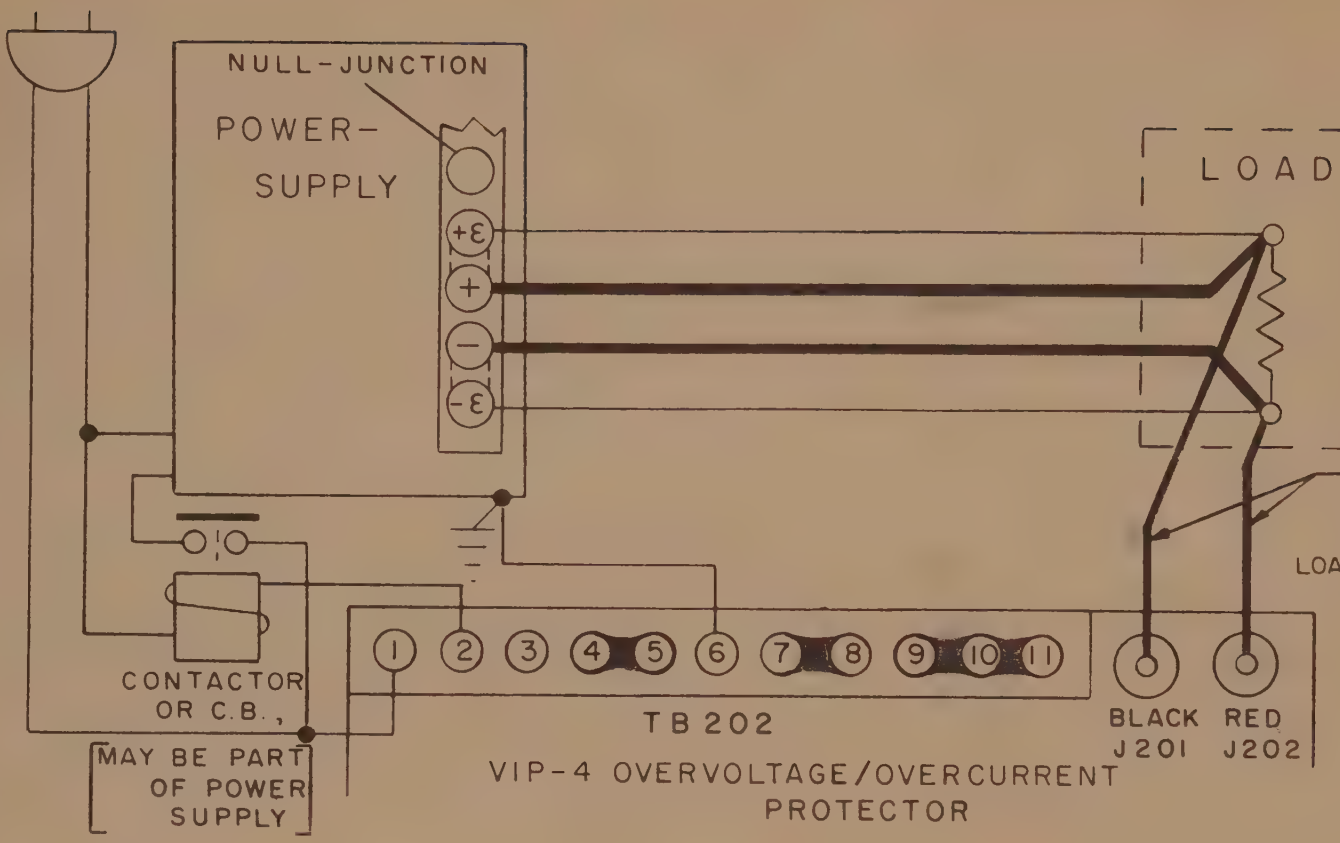


FIG. 3-1 STANDARD OVERVOLTAGE OPERATION
WITHOUT ERROR SENSING.

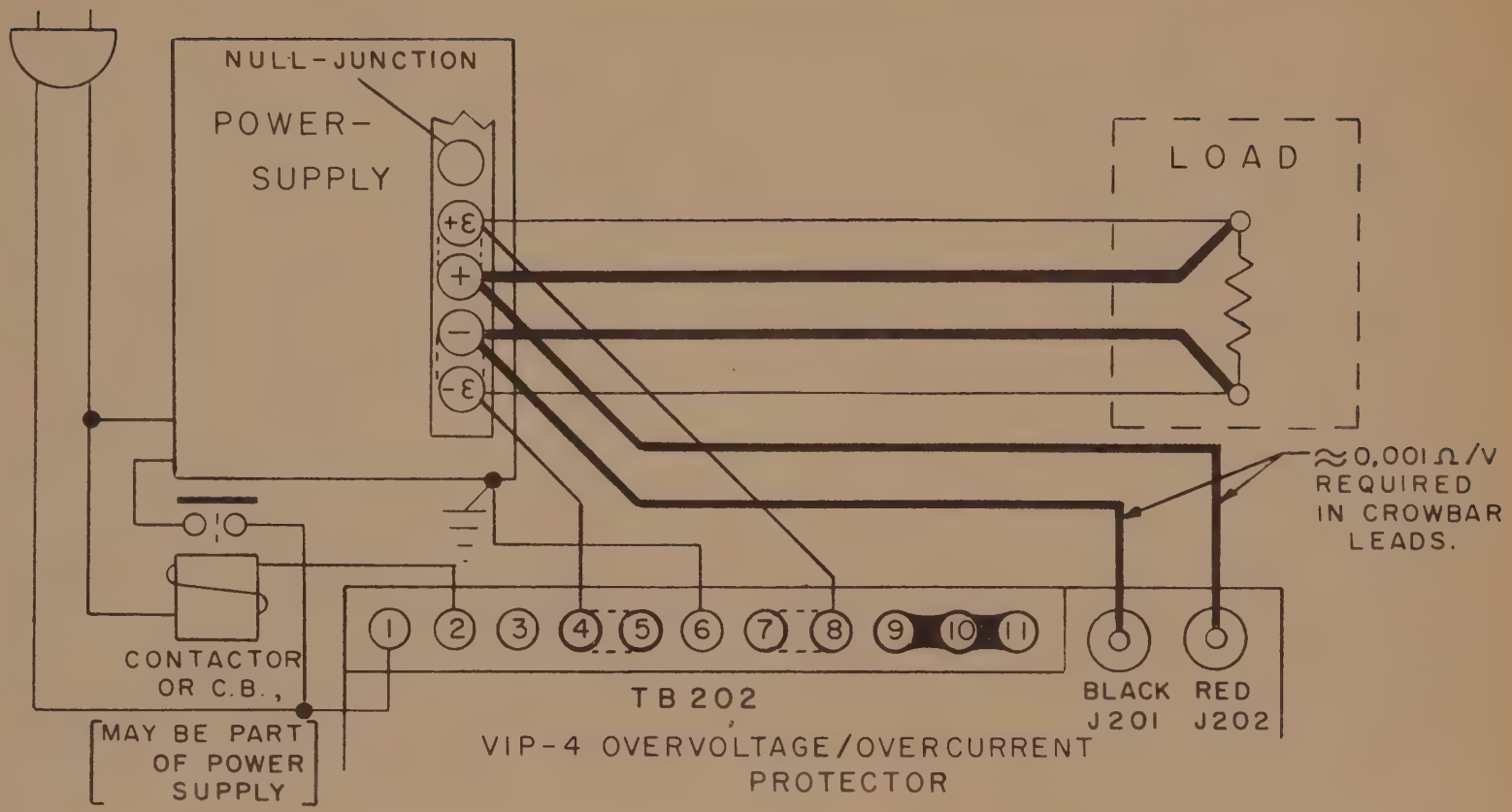


FIG. 3-2 STANDARD OVERVOLTAGE OPERATION WITH ERROR SENSING.

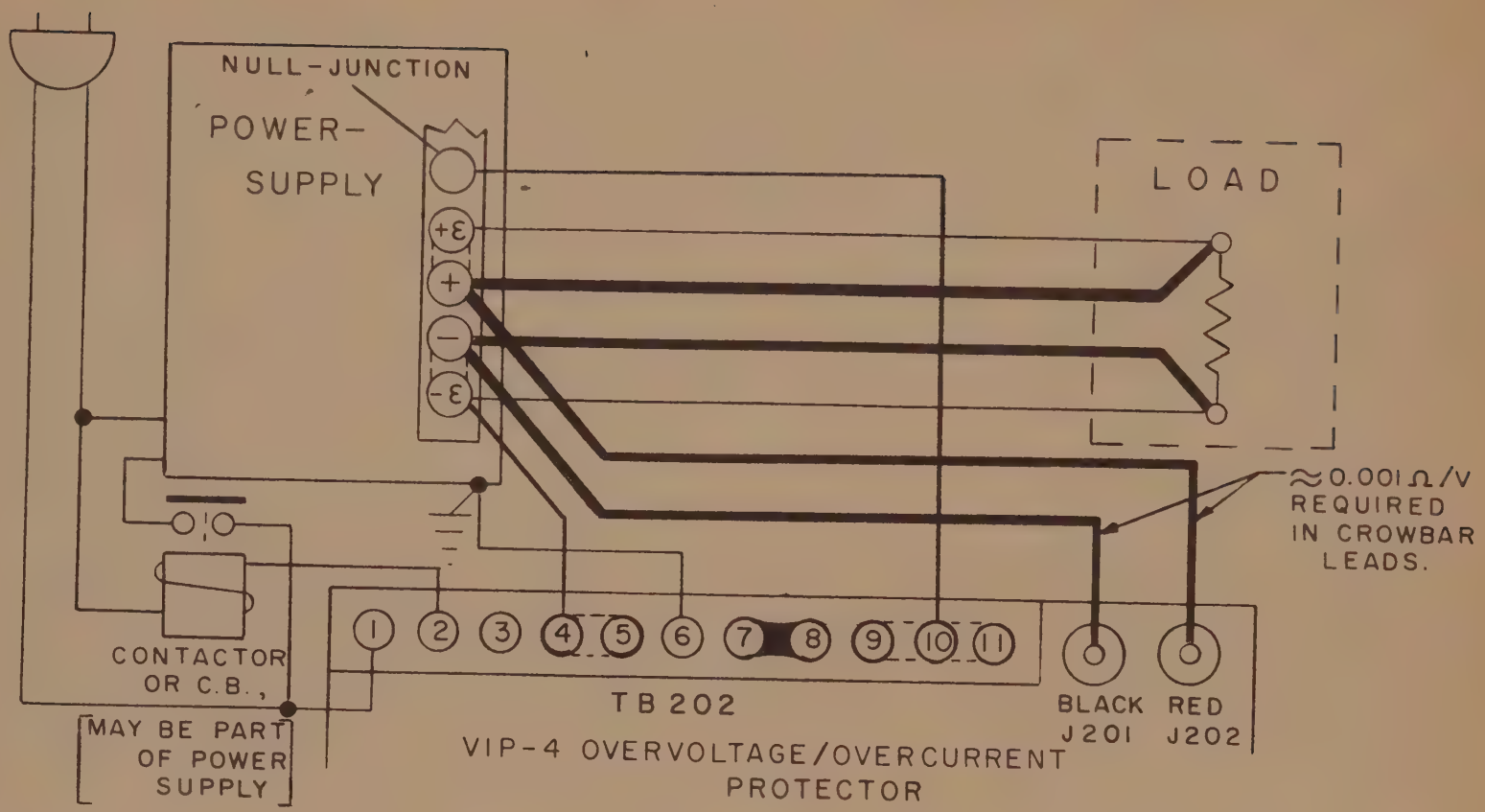


FIG. 3-3 TRACKING OPERATION. (FOR POWER SUPPLIES WITH COMMON NEGATIVE ONLY, PASS-ELEMENTS PNP TYPE, "VOLTAGE CONTROL" ON VIP-4 NOT USED)

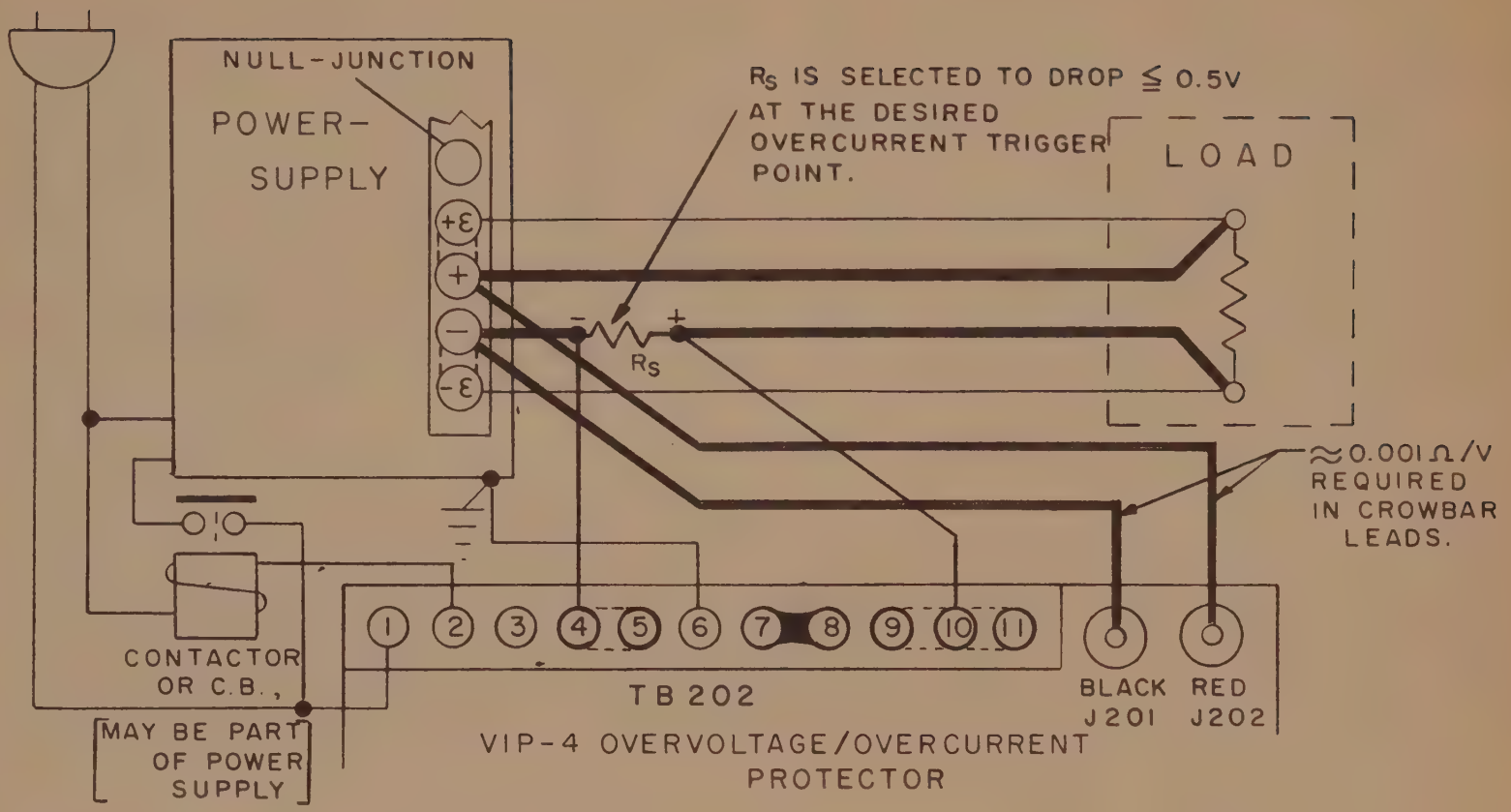


FIG. 3-4. OVERCURRENT OPERATION. ("SENSITIVITY CONTROL" (R101) BECOMES THE "CURRENT CONTROL" IN THIS MODE OF OPERATION. "VOLTAGE CONTROL" (R102) IS NOT USED.)

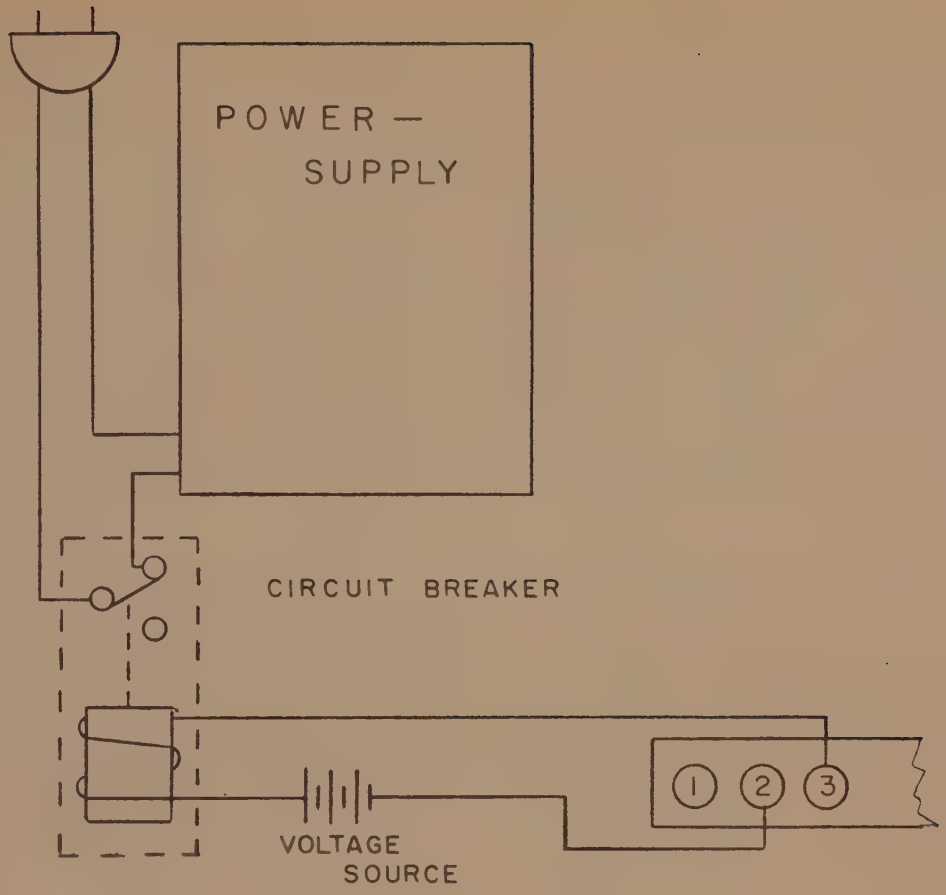


FIG. 3-5 ALTERNATE METHOD OF DISCONECTING LINE.

SECTION IV - CIRCUIT DESCRIPTION

4-1 GENERAL

4-2 This section describes the major circuitry of the KEPCO Model VIP-4 Overvoltage/Overcurrent Protector. The purpose of the analysis is to provide the user with a functional understanding of the equipment, thus forming a basis for successful operation and maintenance.

4-3 AC INPUT CIRCUIT (Refer to Main Schematic, FIG. 5-3)

4-4 AC line power is introduced through a heavy duty, three wire line cord with polarized plug. When line power switch S101 is closed, line power is applied to T1 the main transformer and DS101 the white AC pilot light. As the secondary voltage builds up, Relay K201 is energized through isolation diode CR5 and C6 and held by its own contacts (1)-(3).

4-5 MAIN DC SUPPLIES

4-6 The operating voltages for the amplifier and control bridge circuits are derived from the secondary winding on T1 rectified by the split bridge rectifier consisting of CR1 through CR4 and filtered by C1 and C2. Following the filtered B+ and B- supplies are two zener regulating stages each, consisting of CR6-CR7 and CR8-CR9 respectively, which produce the final -6.5V and +6.5V operating voltages.

4-7 BRIDGE SENSING CIRCUIT (Refer to FIG. 4-1)

4-8 In the normal overvoltage operating mode, use is made of a voltage comparison bridge circuit. This bridge is formed by the voltage drop across R20 (V_R20), R21 and R22 (R_R), R102 (R_{VC}) and the output voltage of the power supply to which the Model VIP-4 is connected (Ein). A condition of balance exists when: $\frac{E_r}{R_r} = \frac{Ein.}{R_{VC}}$ In this case the voltage between A and A' is virtually zero. This balance is upset however as soon as there is a change in Ein. The unbalance appears as an error signal at the input to the differential amplifier (A) and will subsequently by amplified and directed to the gate of the first silicon controlled rectifier CR13.

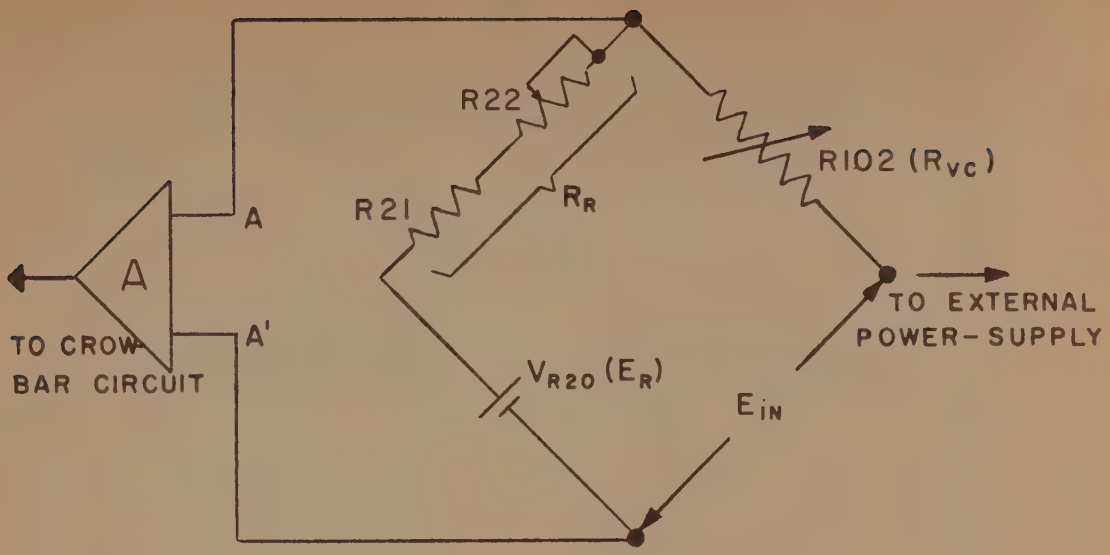


FIG. 4-1 SIMPLIFIED BRIDGE CIRCUIT, VIP-4

4-9 AMPLIFIER AND CROWBAR CIRCUITRY

4-10 A conventional differential amplifier pair consisting of Q1 and Q2 comprise the input circuitry of the Model VIP-4. Q1 is equipped with an offset control (R101) brought out to the front panel (SENSITIVITY), while Q2 is fed directly from the null junction of the sensing bridge. The error signal is then transfered to a low hysterisis Schmitt Trigger (Q3 and Q4) which when activated, applies a gate turn-on signal to the small silicon controlled rectifier CR13. CR13 now fires the large S.C.R. (CR201) which when conducting crowsbars the output of the power supply connected to the Model VIP-4. Simultaneously, CR13 also places a short circuit through CR15 across the coil of the previously activated relay K201 and turns the FAULT light (DS103) on. Due to the de-activating of K201 the OPERATE light (DS102) goes out and the ALARM outlet (J203) is energized. Rear terminals (1) and (2) on rear barrier strip TB202 are now open circuited, while terminals (2) and (3) are shorted. (These terminals are provided to control an external circuit breaker or contactor which would in turn control the input power of the power supply used.)

4-11 The above described sequence takes place with the TEST/OPERATE switch in the OPERATE position. In the TEST or set-up position, the sequence differs from the above description in the following respects:

a) The gate and cathode of the crowbar S.C.R. (CR201) are shorted out and CR201 can consequently not be triggered.

b) CR13 is disconnected from the relay coil on K201 and from its sustaining voltage, which was previously derived through R15 and CR14. K201 will therefore not be de-energized.

c) The operating voltage for DS102 is removed and the OPERATE light will therefore be out.

d) The FAULT light (DS103) is fed from rectified but unfiltered DC, dropping through zero twice during each cycle. CR13 therefore does not remain continuously conducting when triggered. This allows the unit to be set up with S102 in the TEST position without triggering the large S.C.R. (CR201) and thereby crowbaring and disabling the power supply.

SECTION V - MAINTENANCE

5-1 GENERAL

5-2 This section contains information for the maintenance, internal adjustments and measurements of the KEPCO Model VIP-4 Overvoltage/Overcurrent protector.

5-3 PRECAUTIONS

5-4 No parts in this device should be replaced with substitutes not specified in the parts list (Section VI). No adjustments or circuit changes must be made other than those described in this section. Replacements or adjustments made without understanding the effects may cause serious damage to the device.

5-5 TEST EQUIPMENT REQUIRED

5-6 The following is a list of test equipment required to test and adjust the Model VIP-4.

a) Variable transformer capable of adjusting the powerline from either 105 to 125V AC or 210 to 250V AC, to test the Model VIP-4 over its specified input range.

b) Power supply, feedback regulated, output voltage range 0 to 60 volts KEPCO Model CK 60-0.5 or its equivalent. (Two are required if the VIP-4 is to be tested in the Overcurrent mode of operation.

c) Voltage Monitor, differential or digital voltmeter with a resolution of at least 10 mV and a range covering the maximum operating range of the Model VIP-4. DIGITEC Model 201 or its equivalent.

d) Multimeter, Weston Analyzer, Model 980 or its equivalent, for general trouble-shooting and voltage measurements.

5-7 INTERNAL BRIDGE CURRENT ADJUSTMENT

5-8 The internal adjustment for the comparison bridge current if factory adjusted to a value that allows the Model VIP-4 to accomodate power supplies up to and including 50 volts output voltage with the VOLTAGE CONTROL on the front panel turned completely clockwise. The

adjustment of the internal bridge current control is necessary only following the control's or its associate components' replacement.

5-9 PROCEDURE

a) Connect power supply and digital or differential voltmeter across the rear terminals on the VIP-4 (J201-J202) Set OPERATE/TEST switch to TEST. Set SENSITIVITY and VOLTAGE CONTROL to their maximum clockwise positions.

b) Turn the Model VIP-4 on <u>first</u>. Turn on power supply and set to exactly 52 volts output.

c) If the Model VIP-4 has triggered while the power supply was advanced to 52 volts turn R22 (Refer to FIG. 5-2 for location) counter clockwise and repeat paragraph 5-9B.

d) If Model VIP-4 does not trigger when reaching 52 volts on the power supply adjust R22 clockwise until triggering just occurs as indicated by the lighting of the red FAULT light. This concludes the adjustment.

5-10 TROUBLE SHOOTING

5-11 Modern solid state devices require thourough understanding of the problems involved in repairing complex feedback circuitry. Servicing beyond simple part replacements should consequently be attempted only by personnel thoroughly familiar with solid state component techniques and with experience in closed loop circuitry.

5-12 "Trouble shooting charts", showing resistance and voltage readings on various parts of the circuitry are of very limited usefulness with feedback amplifiers and are not included here. Presented instead are a detailed circuit description (Section IV), parts location diagrams (FIG'S. 5-1 and 5-2) and the main schematic (FIG. 5-3) with all significant voltage readings.

5-13 The following basic steps in case of a malfunction may be found useful:

a) Device does not function at all: Check all power line connections and make certain that fuses are intact and device if connected to the correct line voltage. (It is normally delivered for 115V AC operation, if not specified otherwise).

b) If device shows spurious triggering, investigate the ground connections of both, the VIP-4 and the power supply. As indicated in all operational set-up diagrams in Section III, the ground connection should be common to both instruments, as short as possible, and returned to a solid AC ground.

c) A large percentage of field-failures is due to <u>incorrect external connections.</u> Check all external set-ups against the diagrams provided in Section III.

d) Only after points A through C above have been thoroughly covered should an internal analysis begin. The transistors should be checked on a reliable transistor checker. The voltage readings are taken in the TEST position and with a 50 volt power supply connected to the VIP-4.

e) KEPCO Field Engineering Offices or the KEPCO Repair Department will be available for consultation or direct help in difficult service or application problems.

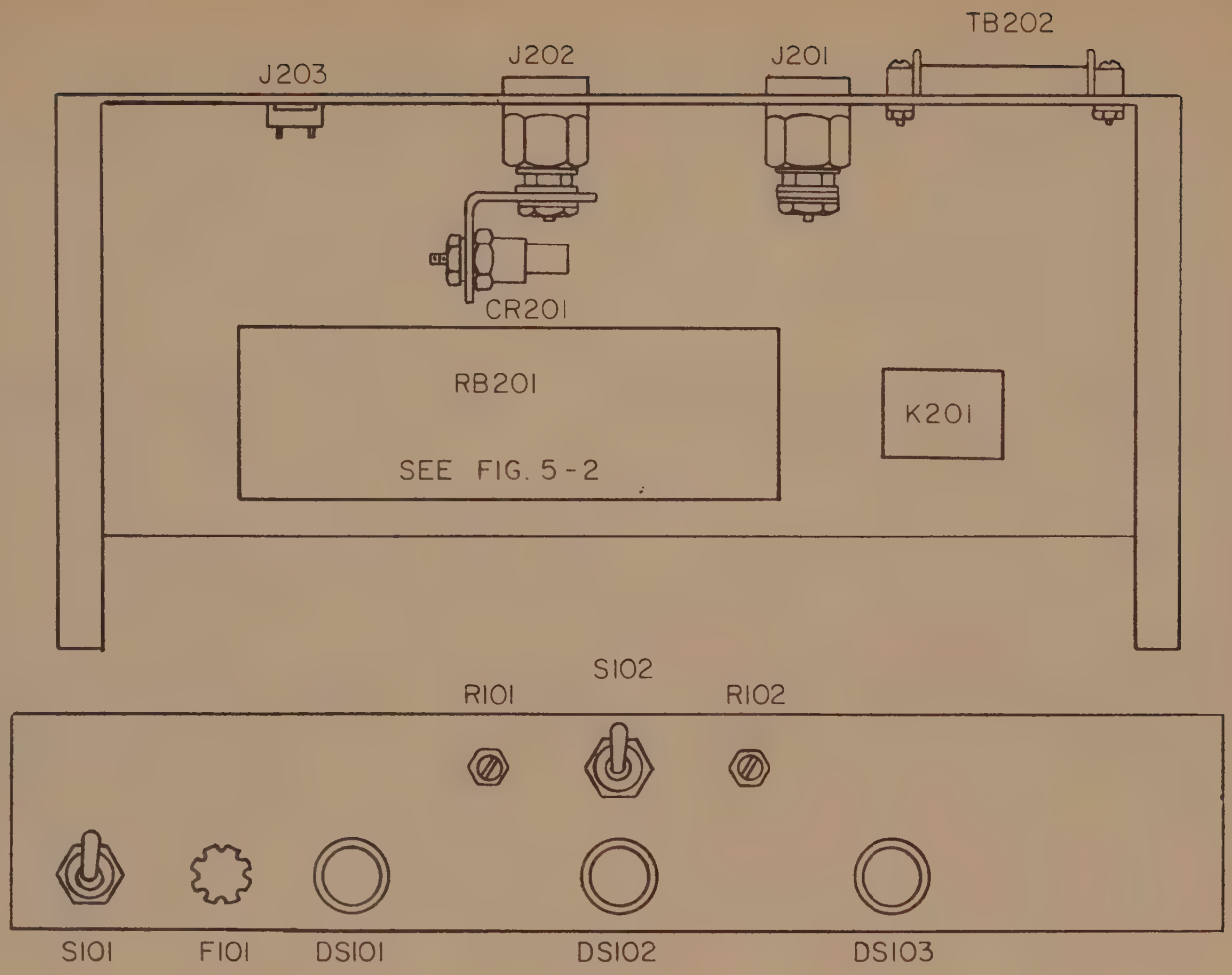


FIG. 5-1 COMPONENT LOCATION (MAIN CHASSIS)

BM06264

REVISIONS	DRAWN	CHKD.	APPD.	DATE

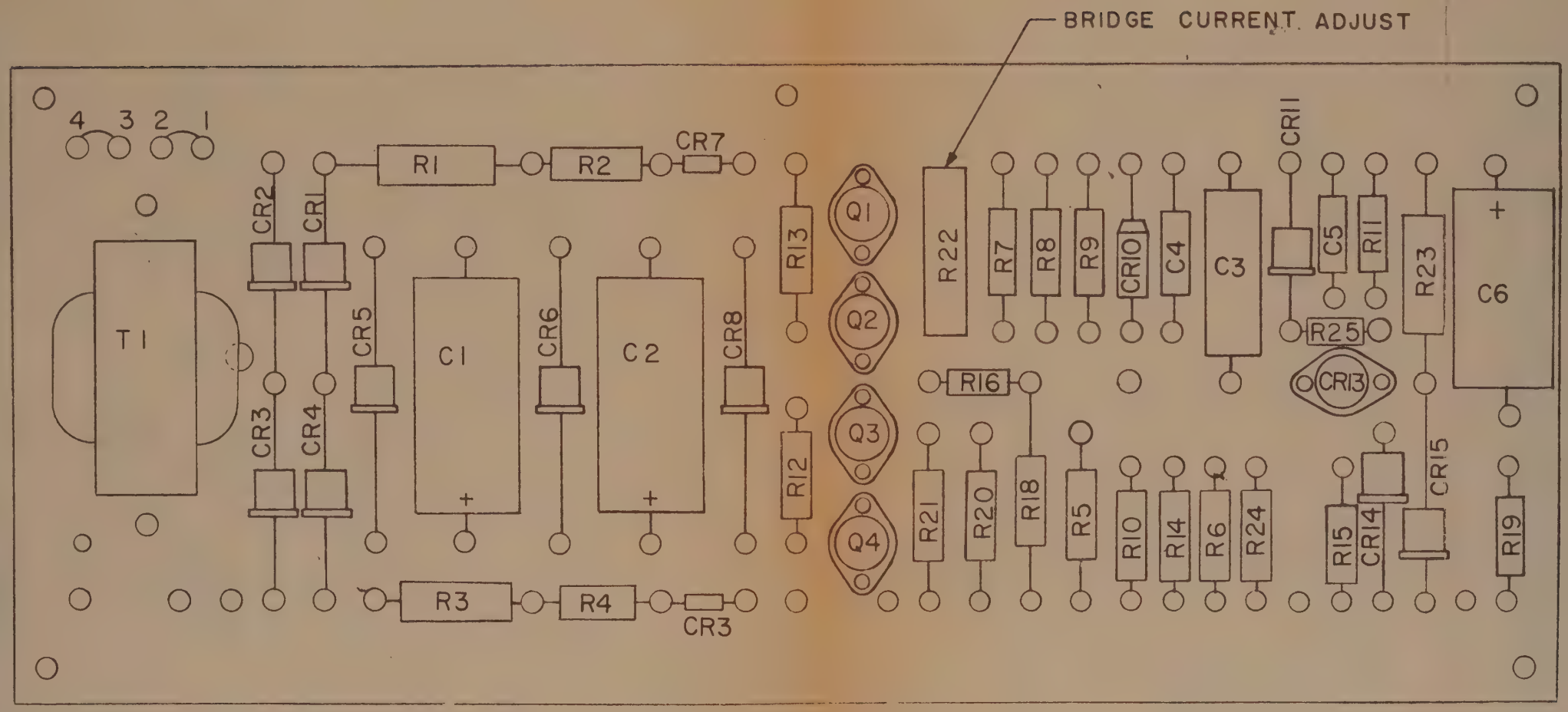


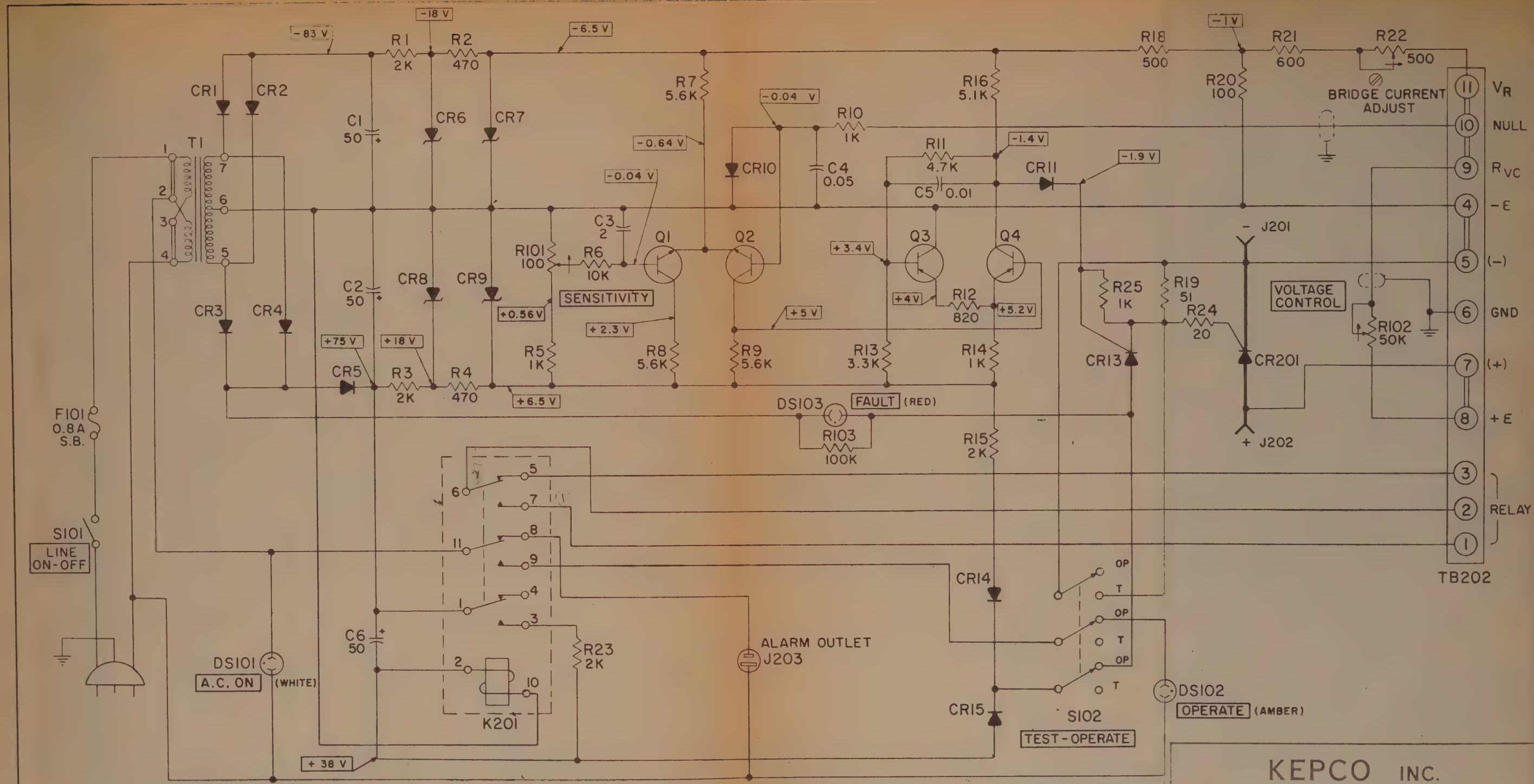
FIG. 5-2 COMPONENT LOCATION, VIP-4
PRINTED CIRCUIT BOARD

KEPCO INC.
FLUSHING N.Y.

RESISTOR BOARD, RB 201

DRAWN	CHKD.	APPROVED	DATE
H. DJ.		JB	11-27-68
MODEL NO.		PART NO	SCALE
VIP-4			—

DWG. NO BM06264



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS, K=1000. ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. COMPONENT SERIES 1-99 MOUNTED ON PRINTED CIRCUIT BOARD, 101-199 ON FRONT PANEL, 201-299 MOUNTED ON MAIN CHASSIS.
3. VOLTAGE READINGS ARE DC, TYPICAL VALUES AND MEASURED IN RESPECT TO TERMINAL (4) ON TB202 WITH VTVM, Zi = 200 MΩ, ALL CONTROLS MAX. CLOCKWISE, 50 VOLT POWER SUPPLY CONNECTED TO J201-J202, AC LINE AT 115V AC INPUT.
4. TRANSFORMER CONNECTIONS SHOWN ARE FOR 115 V AC OPERATION.

KEPCO INC.
FLUSHING, N.Y.

TITLE: DESIGN SCHEMATIC

DRAWN	CHECKED	APPROVED	DATE
E.R.			11-27-68

MODEL NO.	PART NO.	SCALE
VIP-4		

DWG. NO. BM06265

FIG. 5-3 MAIN SCHEMATIC

REPLACEMENT PARTS LIST

PRINTED CIRCUIT BOARD ASSEMBLY, MODEL VIP 4 Code 11-2768

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE NOTE)	KEPCO PART NO.
C1,2,6	3	Capacitor, Electrolytic, Pigtail 50 µF, 150 V	Industrial Cond. 10B936	117-0127
C3	1	Capacitor, Mylar 2.0 µF, 200 V, 10%	Good All X663-F	117-0129
C4	1	Capacitor, Mylar 0.05 µF, 200 V, 20%	Sprague 192P503025	117-0315
C5	1	Capacitor, Mylar 0.01 µF, 200 V	Sprague 192P10302	117-0353
CR1,2,3, 4,5	5	Rectifier, Silicon	Semicon SM140/S	124-0028
CR6,8	2	Zener Diode, Pigtail	Motorola 10M30Z	121-0036
CR7,9	2	Zener Diode, Pigtail	IRC AN267	121-0028
CR10	1	Rectifier, Silicon, Pigtail	Solitron HVP	124-0178
CR11, 14,15	3	Rectifier, Silicon	Semicon SM110	124-0133
CR13	1	Rectifier, Silicon (SCR)	General Electric C5G	124-0234
Q1,2	2	Transistor, Silicon, NPN	General Electric 2N336A	119-0056
Q3,4	2	Transistor, Silicon, PNP	Hughes 2N1131A	119-0055
R1,3,23	3	Resistor, Fixed, Power, Axial 2 K ohm, 5 W, 5%	Tepro TS5W TS5W	115-0568
R2,4	2	Resistor, Fixed, Molded 470 ohm, 1 W, 10%	Allen Bradley GB4711	115-0630
R5	1	Resistor, Fixed, Power, Axial 1 K ohm, 3 W, 5%	Tepro TS3C	115-1302
R6	1	Resistor, Fixed, Molded 10 K ohm, 1/2 W, 10%	Allen Bradley EB1031	115-0489
R7,8,9	3	Resistor, Fixed, Molded 5.6 K ohm, 1/2 W, 5%	Allen Bradley EB5625	115-0559
R10,25	2	Resistor, Fixed, Molded 1 K ohm, 1/2 W, 10%	Allen Bradley EB1021	115-0547
R11	1	Resistor, Fixed, Molded 4.7 K ohm, 1/2 W, 5%	Allen Bradley EB4725	115-0350

NOTE:

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS, REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

kepco® REPLACEMENT PARTS LIST

PRINTED CIRCUIT BOARD ASSEMBLY, MODEL VIP 4 Code 11-2768

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE NOTE)	KEPCO PART NO.
R12	1	Resistor, Fixed, Molded 820 ohm, 1/2 W, 5%	Allen Bradley EB8215	115-0956
R13	1	Resistor, Fixed, Molded 3.3 K ohm, 1/2 W, 5%	Allen Bradley EB3325	115-0452
R14	1	Resistor, Fixed, Molded 1.0 K ohm, 1/2 W, 5%	Allen Bradley EB1025	115-0340
R15	1	Resistor, Fixed, Molded 2 K ohm, 1/2 W, 5%	Allen Bradley EB2025	115-0520
R16	1	Resistor, Fixed, Molded 5.1 K ohm, 1/2 W, 5%	Allen Bradley EB5125	115-1659
R18	1	Resistor, Fixed, Power, Axial 500 ohm, 3 W, 5%	Hardwick Hindle 728	115-0459
R19	1	Resistor, Fixed, Molded 51 ohm, 1/2 W, 5%	Allen Bradley EB5105	115-0940
R20	1	Resistor, Fixed, Power, Axial 100 ohm, 3 W, 5%	Tepro TS3C	115-0471
R21	1	Resistor, Fixed, Power, Axial 600 ohm, 3 W, 5%	Hardwick Hindle 9/16 GA 600 LTC	115-0862
R22	1	Resistor, Variable 500 ohm, 1/4 W, 10%	Bourns 271-1-501	115-0663
R24	1	Resistor, Fixed, Precision 20 ohm, 3 W, 5%	Hardwick Hindle 711	115-0851
T1	1	Transformer	Kepco Magnetics	100-1346

NOTE:

REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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REPLACEMENT PARTS LIST

MAIN CHASSIS ASSEMBLY, MODEL VIP 4 Code 10-666

SCHEMATIC NO.	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (See Note)	KEPCO PART NO.
FRONT PANEL ASSEMBLY, INCLUDES THE FOLLOWING:				
DS101,102 103	3	Pilot Light	General Electric NE51	153-0024
F101	1	Fuse 8/10 A	Bussman MDL-8/10	141-0027
R101	1	Resistor,Variable 100 ohm, 5%, 10 Turn	Bourns 3507S-319-101	115-1447
R102	1	Resistor,Variable 50 K ohm, 10 Turn	IRC Series 8000	115-1678
R103	1	Resistor,Fixed,Molded 100 K ohm, 1/2 W, 10%	Allen Bradley EB1041	115-0809
S101	1	Switch,Toggle,SPST	Carling 2FA53-63	127-0012
S102	1	Switch,Toggle 3PDT	Cutler-Hammer 7615-K2	127-0076
CR201	1	Silicon,Control,Rectifier,Stud	Westinghouse 2N1910	124-0139
K201	1	Relay	Omega 200PC3CX	140-0040

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PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS, REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

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